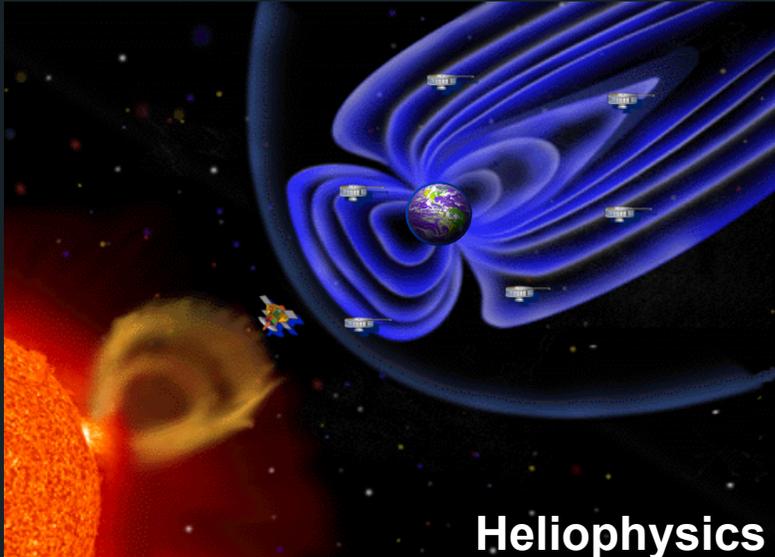


SCIENCE PROGRAMS AT NASA GODDARD

Dr. Nicholas White
Science and Exploration Directorate

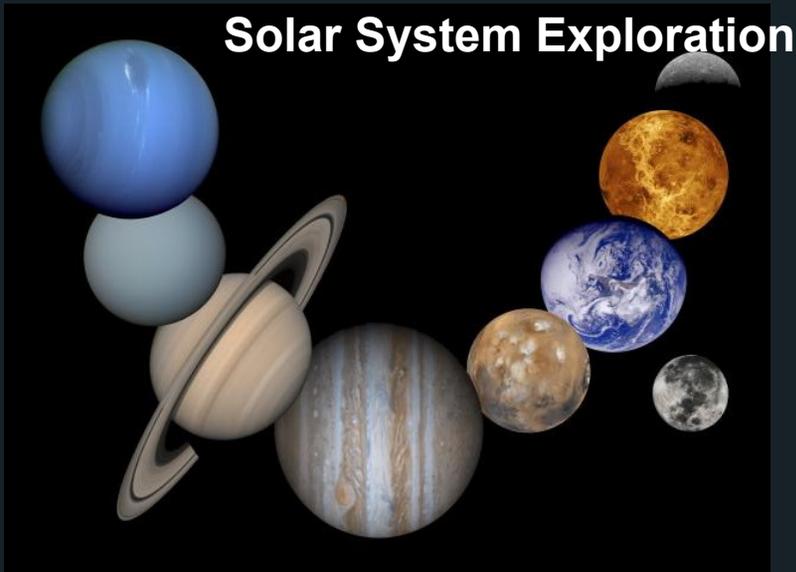




Heliophysics



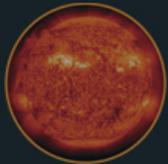
Earth Science



Solar System Exploration



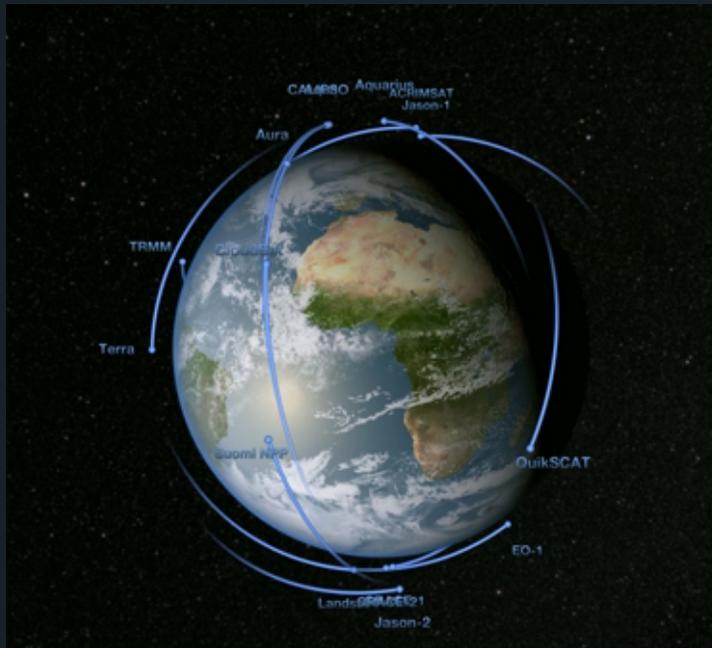
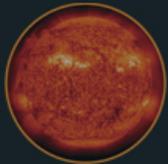
Astrophysics

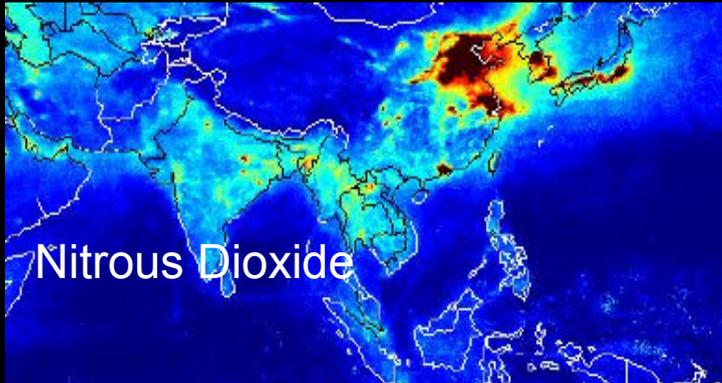


How does the Earth system work?

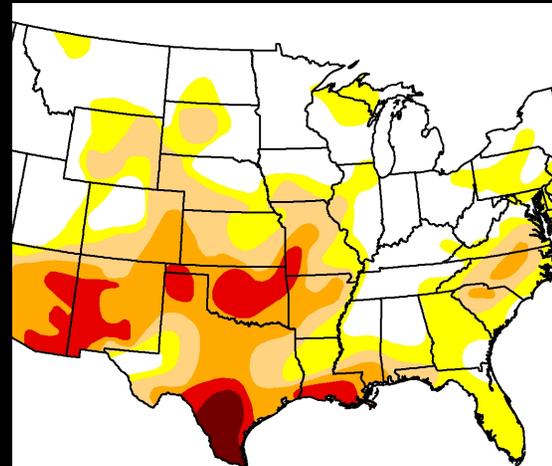
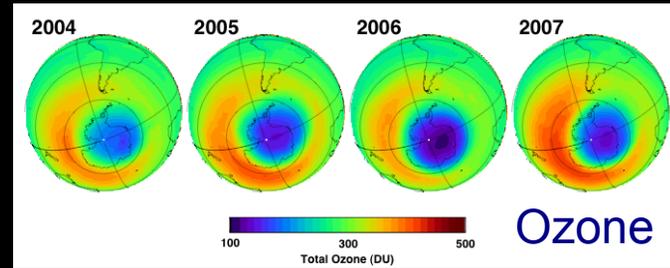
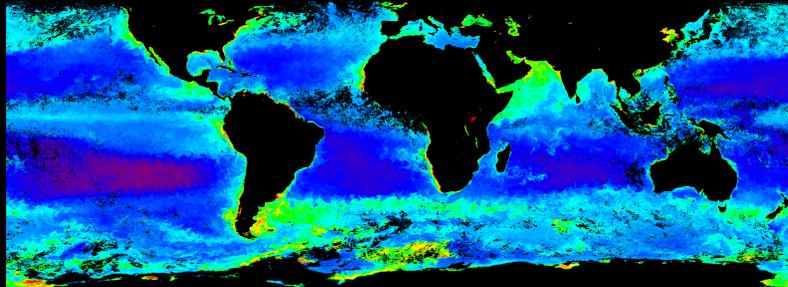
How is the Earth system changing?

How does our changing environment affect life on Earth?

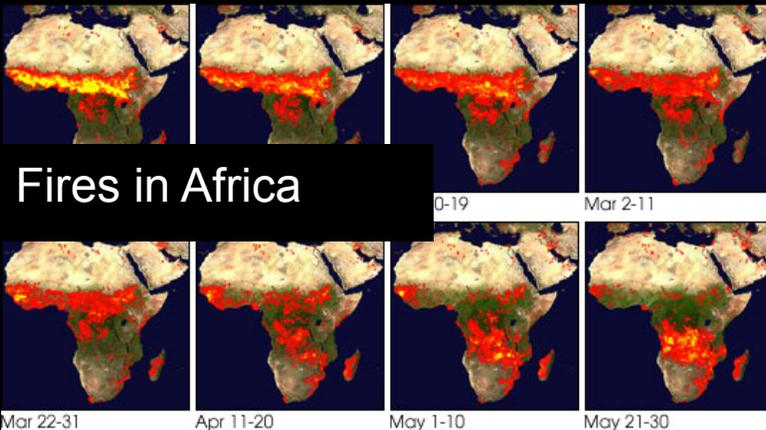




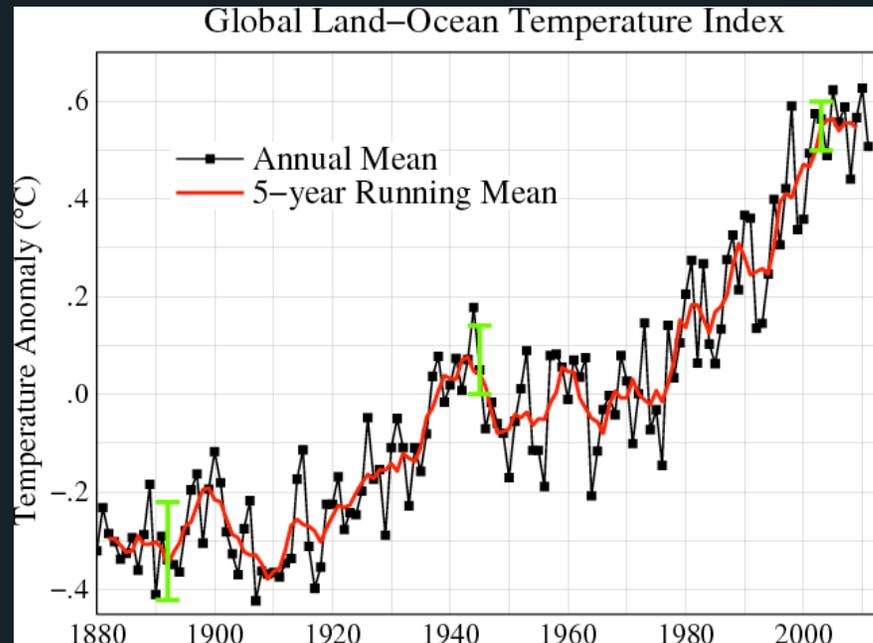
Ocean Color



Ground Water

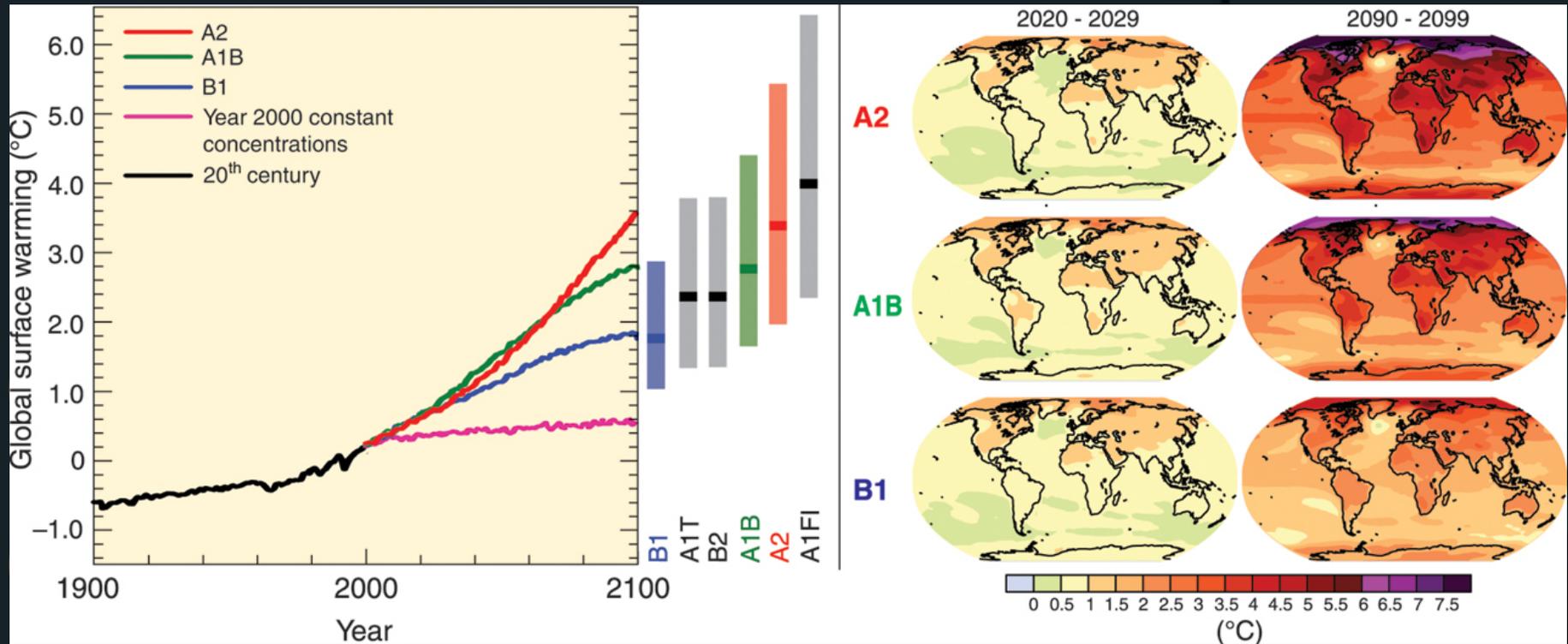


GSFC Scientists Lead Climate Change Research



GSFC scientists are observing and modeling climate change caused by human activities, with the biggest driver increasing Carbon Dioxide – which is causing the Earth to warm-up, resulting in the glaciers and polar ice-caps to melt and other effects on the Earth's climate

Predicting Climate Change



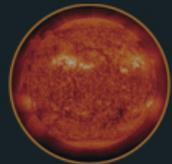
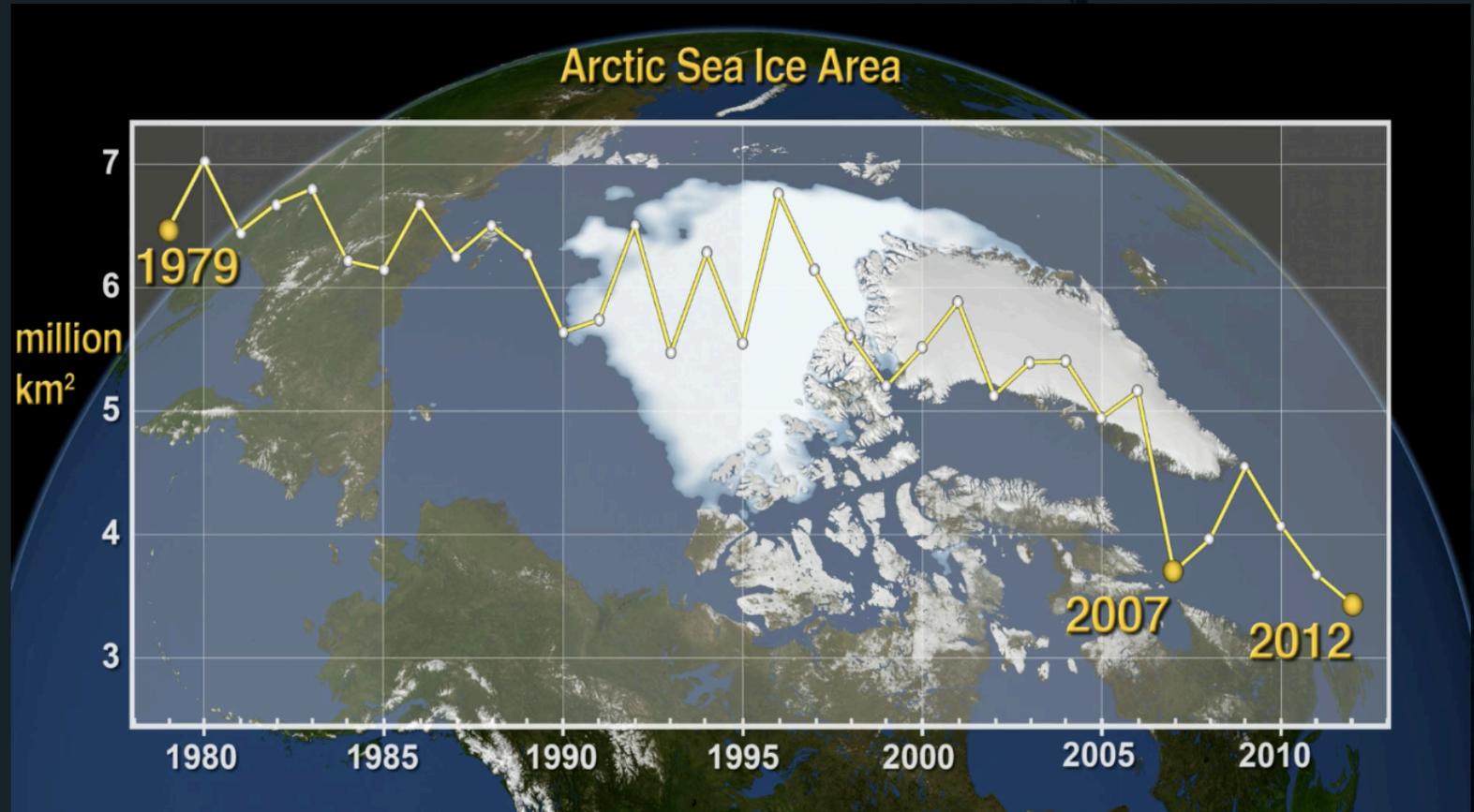
Many different outcomes, depending on what happens with Carbon-dioxide and other greenhouse gas emissions



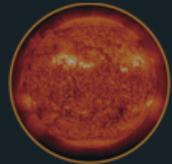
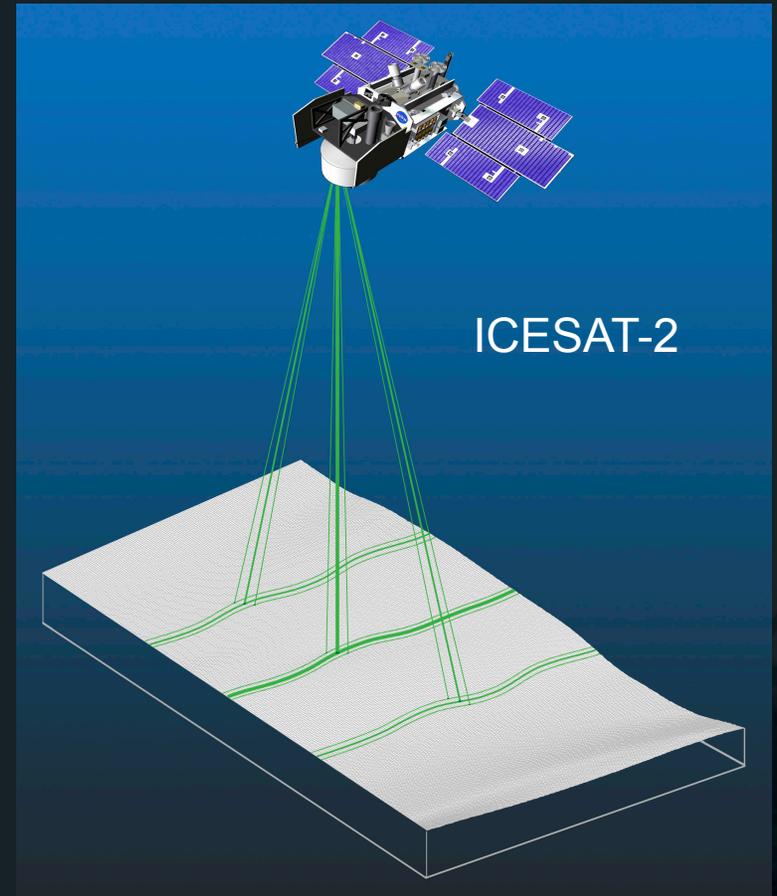
More warming at the poles, major impact on Arctic and Antarctic

The Melting Arctic Ice Cap

The extent of the sea ice covering the Arctic Ocean has shrunk and in 2012 is the smallest seen in the three decades since consistent satellite observations began

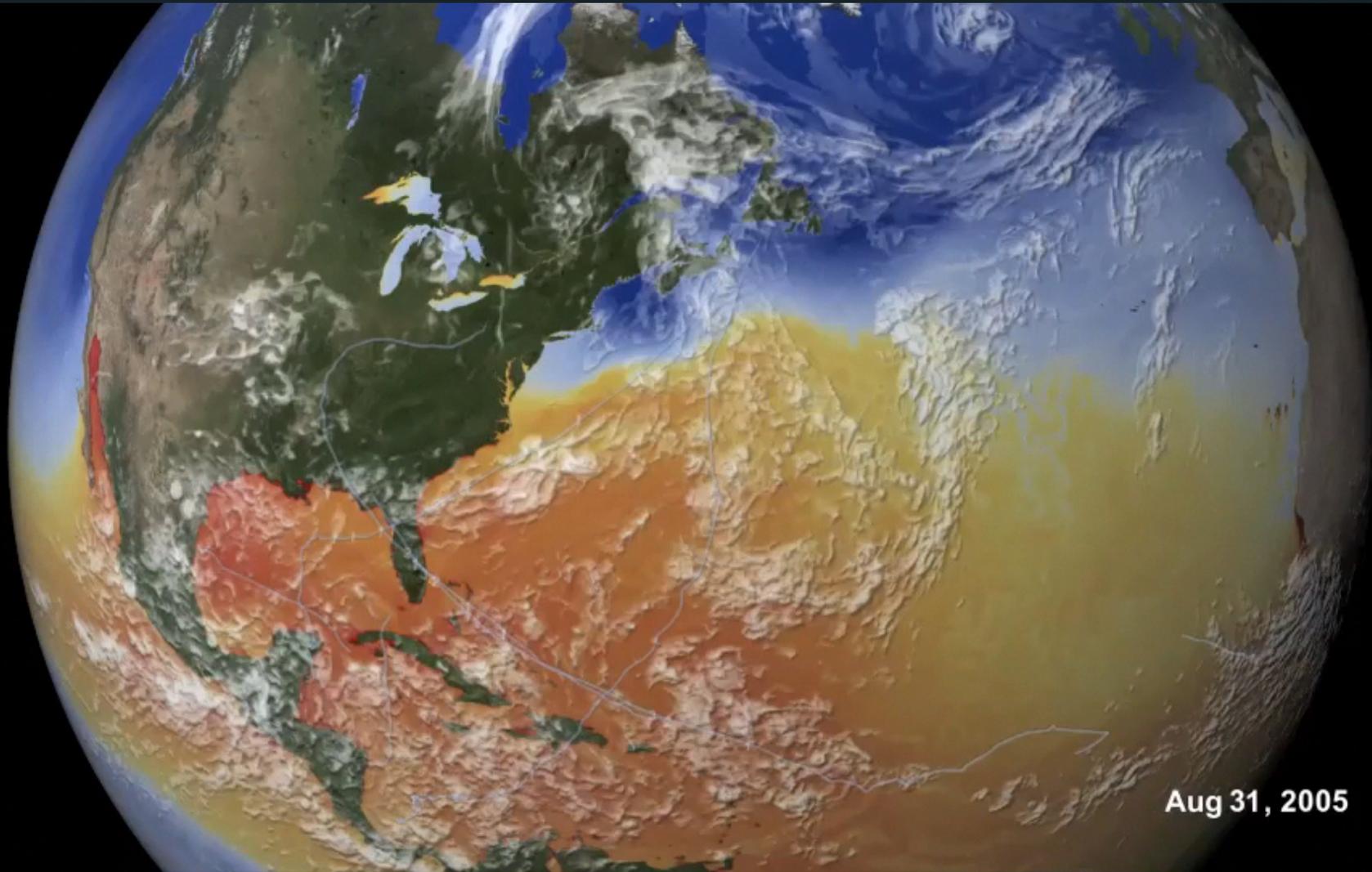


The Glacier covering Greenland is losing the equivalent of all the water in the Chesapeake Bay every year – if it all melts sea levels will rise by ~20 feet



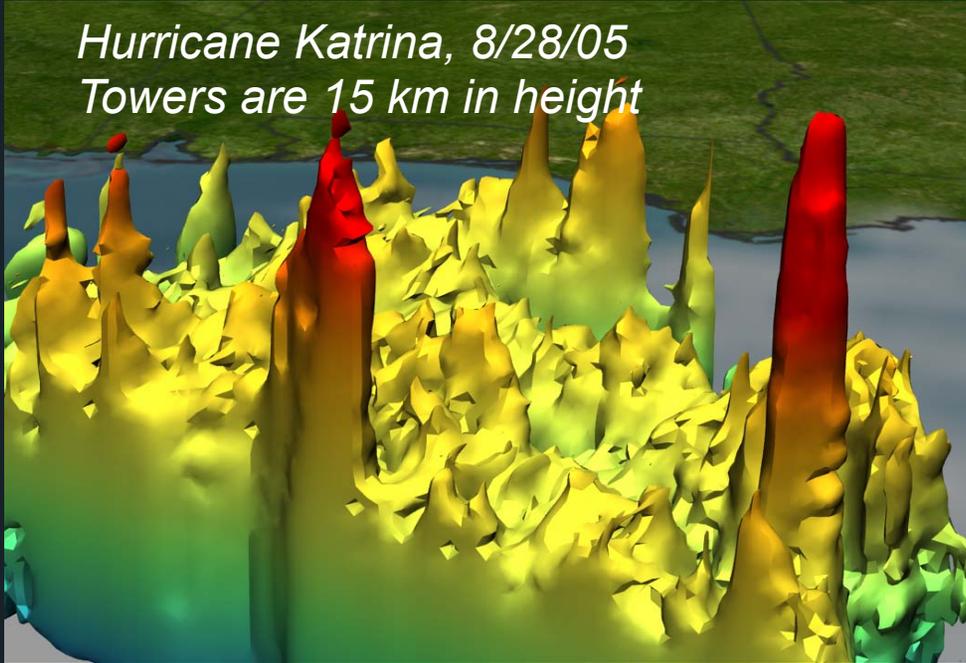
ICESAT2 will continue monitoring the melting of the glaciers in Greenland and the Antarctic – GSFC building the laser Altimeter Instrument

Launch 2015

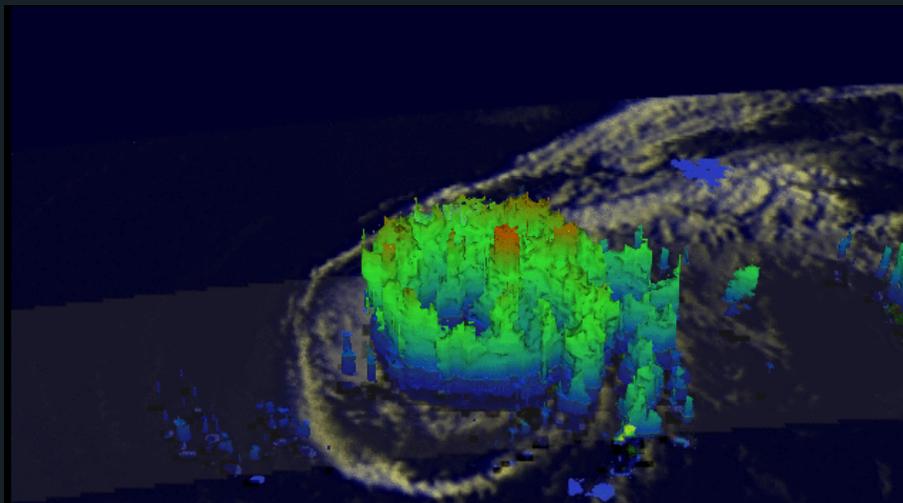
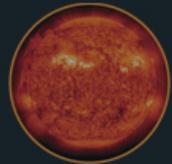


Using super-computers at GSFC to model the 2005 Hurricane season driven by observed sea surface temperatures

Hurricane Katrina, 8/28/05
Towers are 15 km in height



Tropical Radar Measurement Mission radar observations of Katrina, Rita and other 2005 hurricanes revealed towering thunderclouds, called hot towers, that may signify the onset of intensification in storms

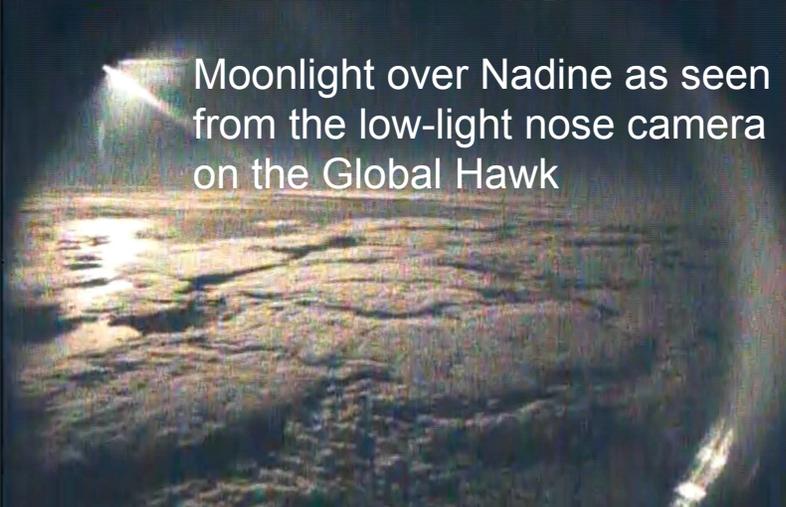
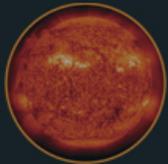
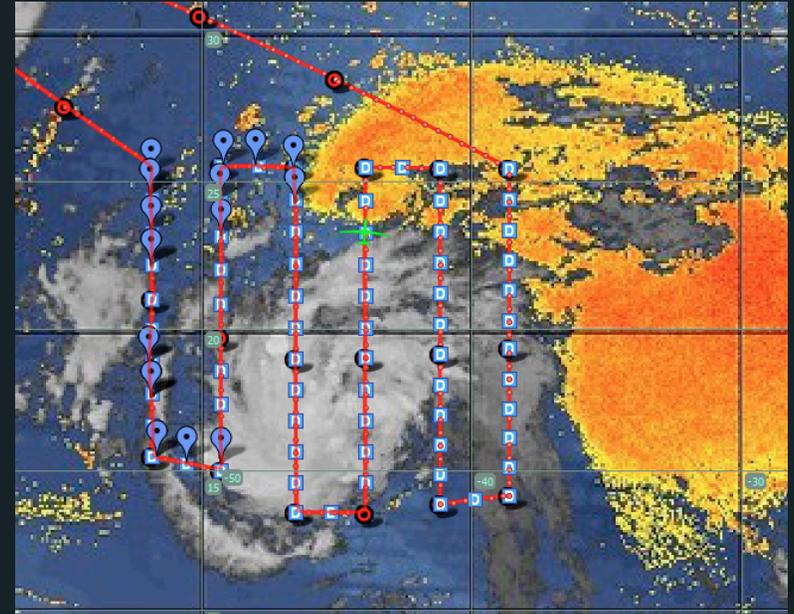


TRMM precipitation radar observations of Nadine on October 2, 2012

HS3: Tropical Storm Nadine (Sept 11-12)

The **Hurricane and Severe Storm Sentinel (HS3)** comprises two Global Hawks for the study of hurricanes and other severe weather systems

Take off from Wallops



Moonlight over Nadine as seen from the low-light nose camera on the Global Hawk

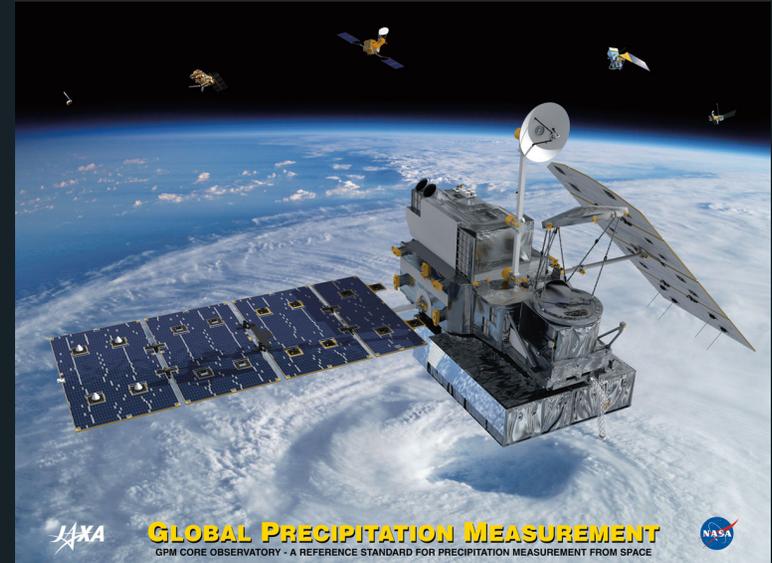


PI: Scott Braun (GSFC)

Advance rainfall and snow measurements from a constellation of microwave sensors

NASA-JAXA partnership

Spacecraft built at GSFC – Launch 2014



Science Goals

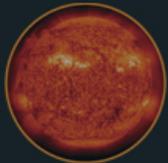
Observe global water cycle in a changing climate

Improved forecasting for weather, floods, landslides, and freshwater resources

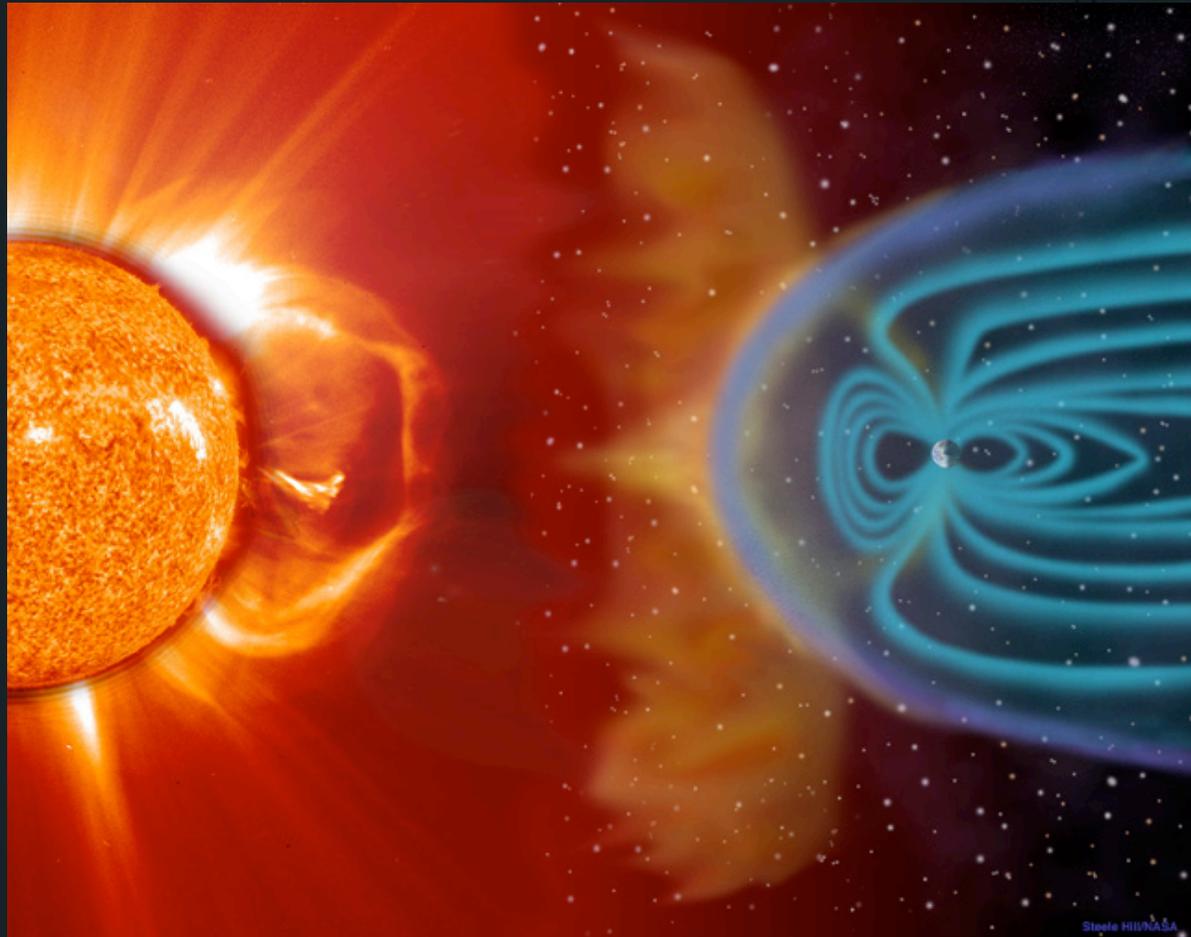
Enhanced near-real-time monitoring of hurricanes & mid-latitude storms

Improved accuracy of rain and snow accumulation

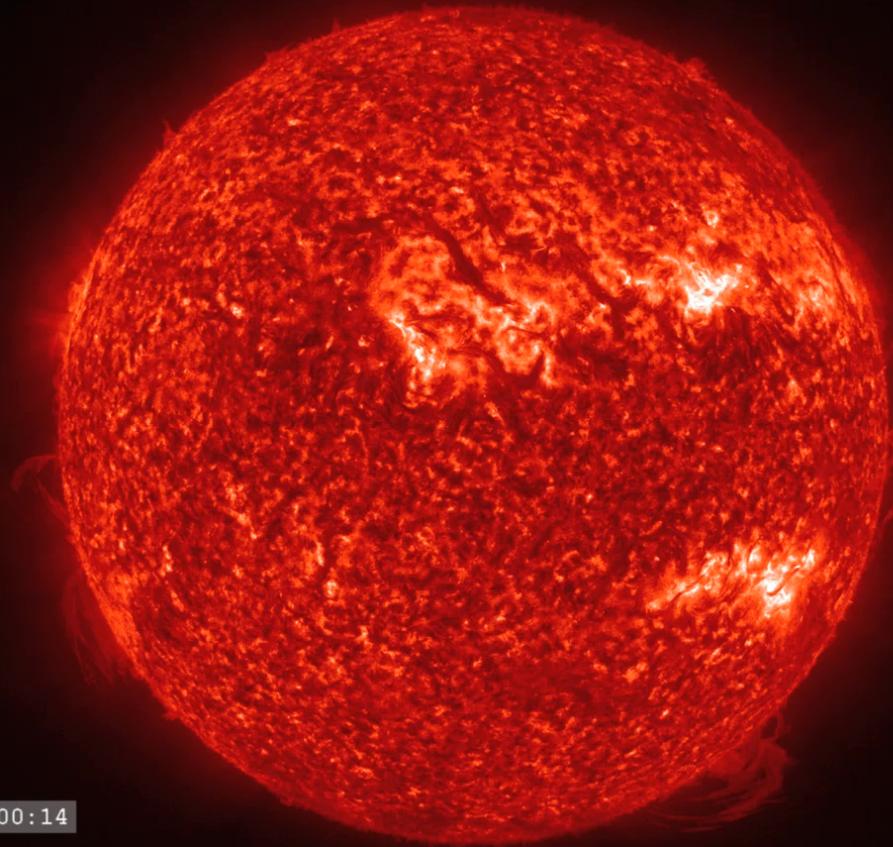
Studying the Sun as a Star and its impact on the Earth



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Steve Hill/NASA



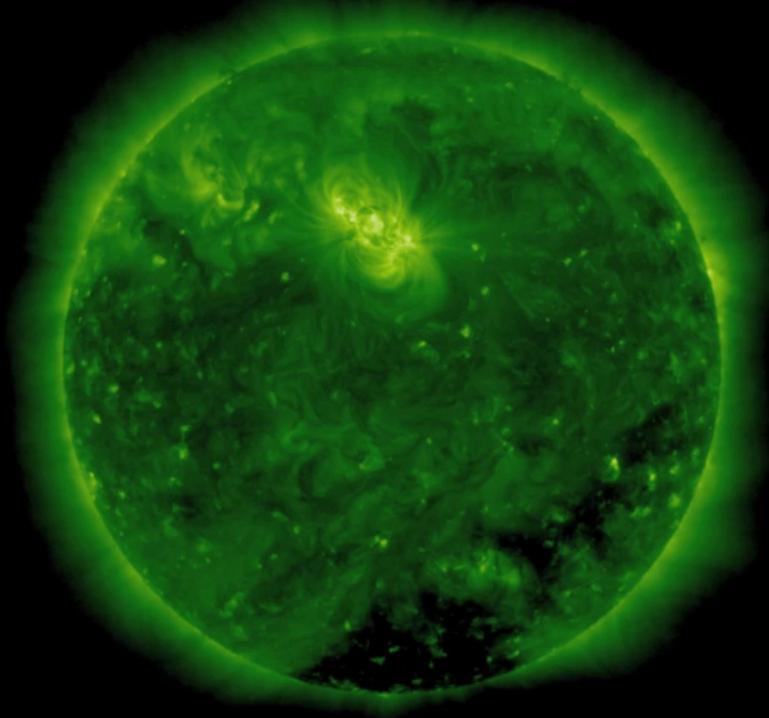
2011 Jun 7 06:00:14



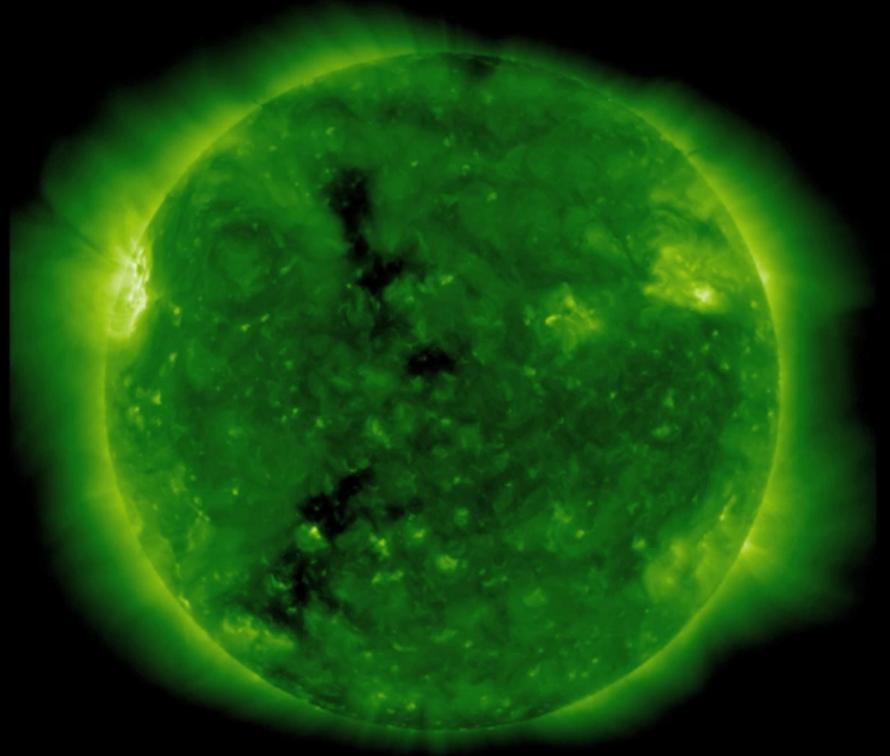
**Solar Dynamics Observatory observes coronal mass ejections
from the Sun June 7, 2011**

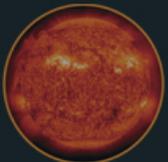
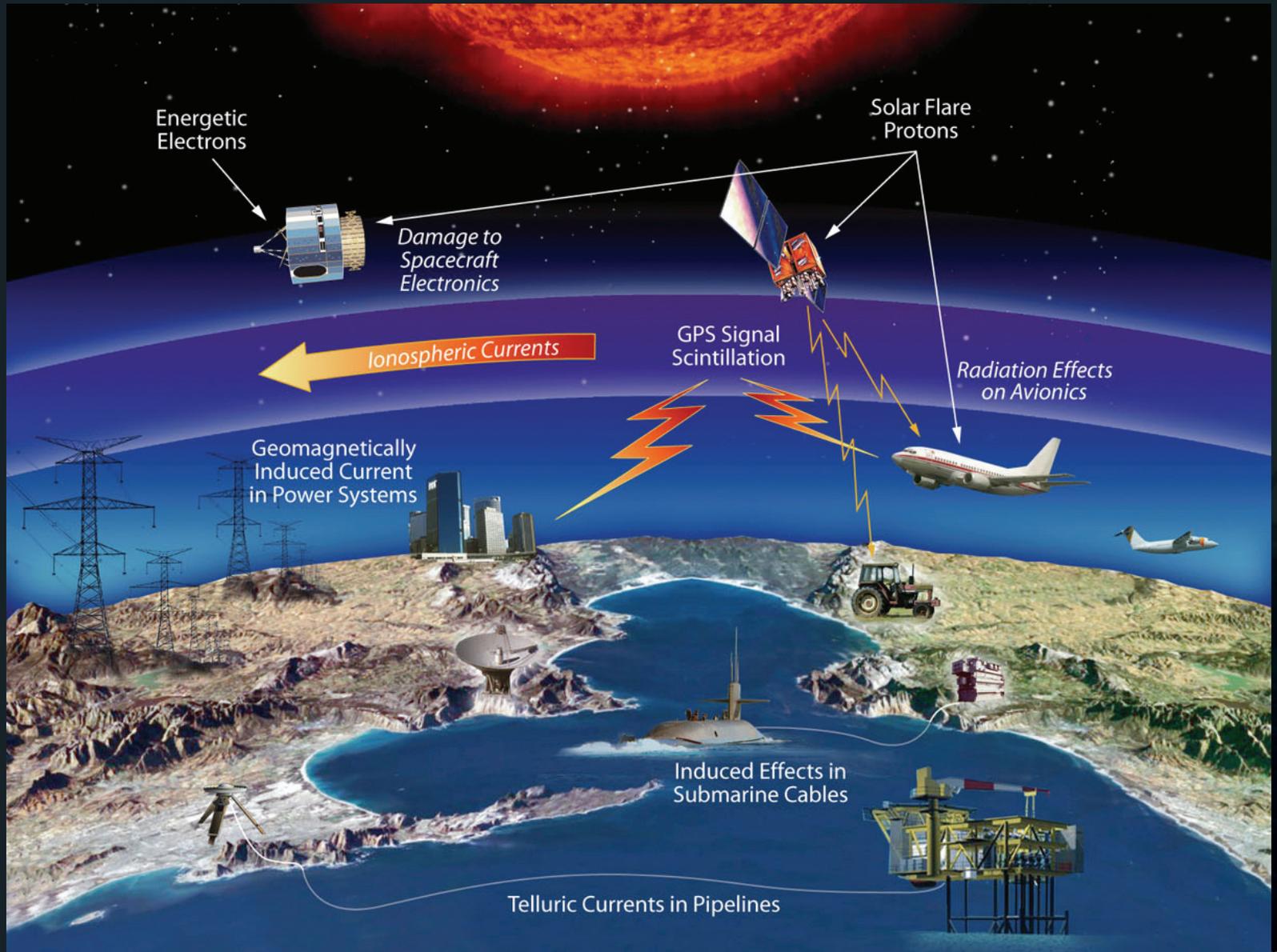
2010 Jul 9 18:15:48

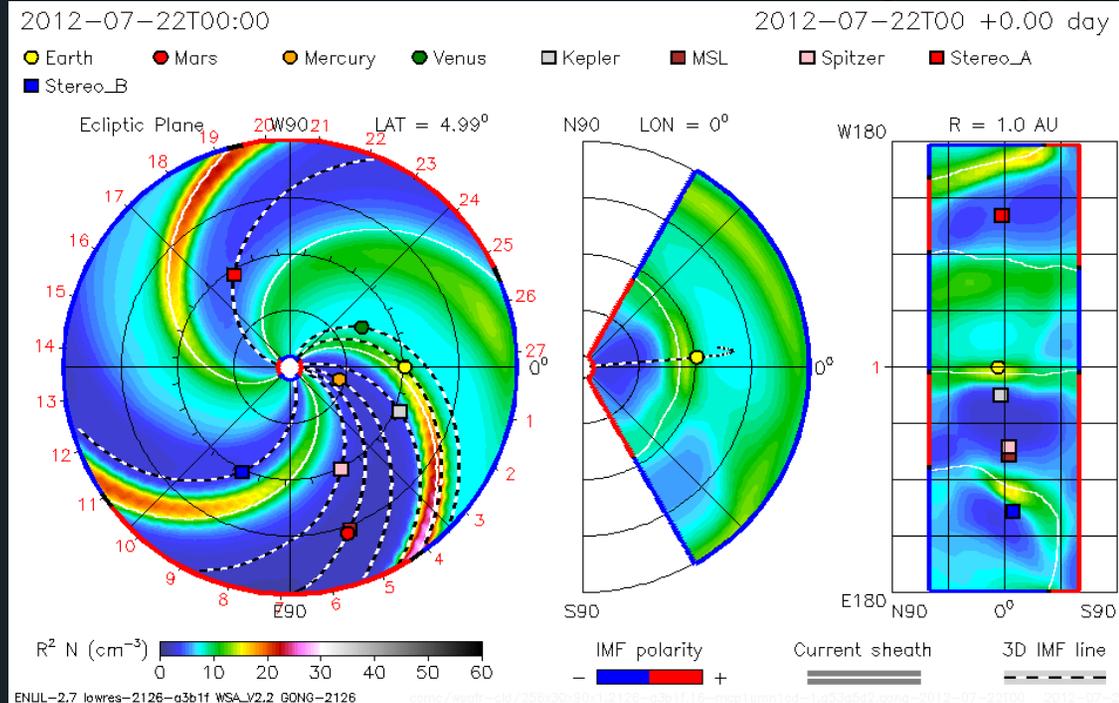
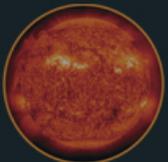
STEREO-B/EUVI 195



SDO/AIA 193

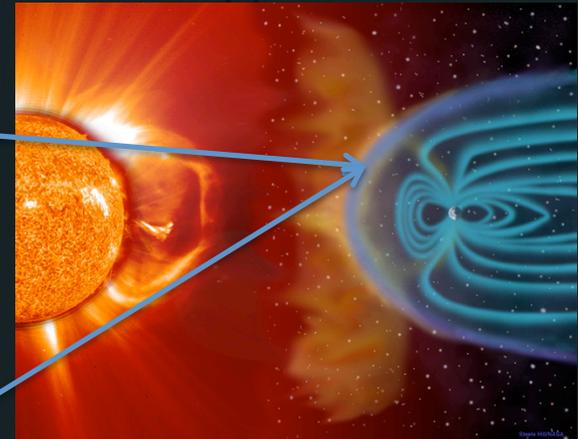
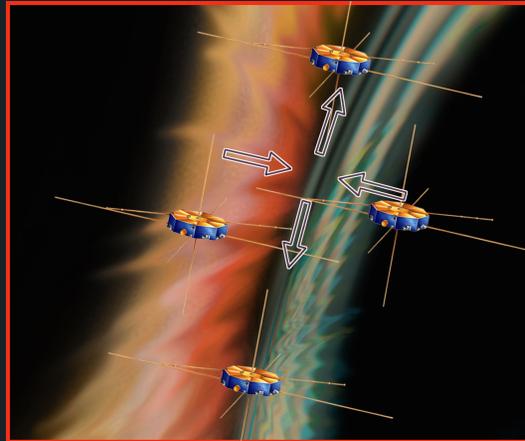
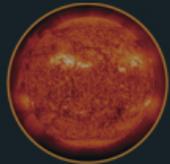






Direct measurements of magnetic reconnection and plasma entry into the magnetosphere

Four Spacecraft flying in formation separated by 10 to 400 km



Each spacecraft is built at GSFC and measures 11x4 ft

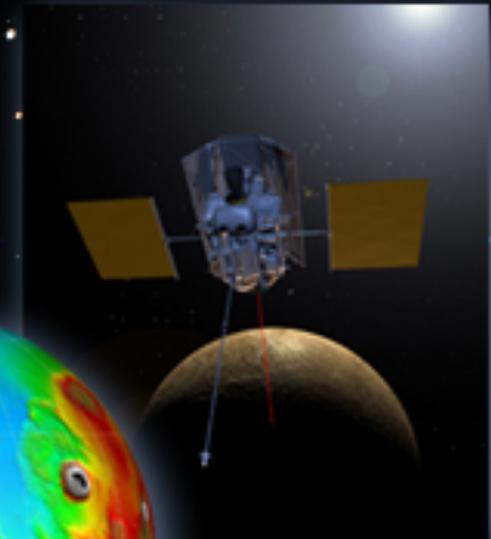
Launch 2014

GSFC has flown more instruments to other planets than any other institution!

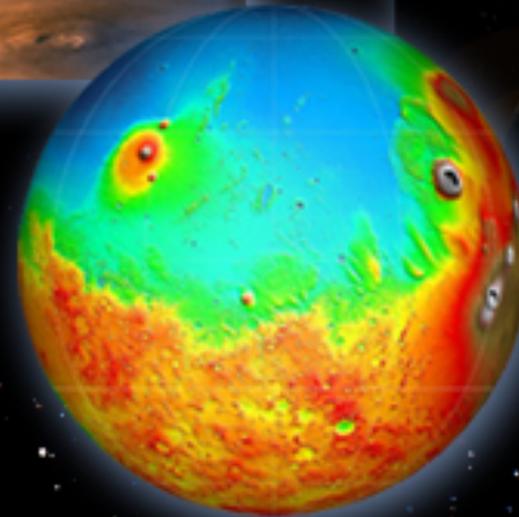
Mars Global Surveyor



Messenger – Mercury Laser Altimeter

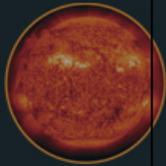
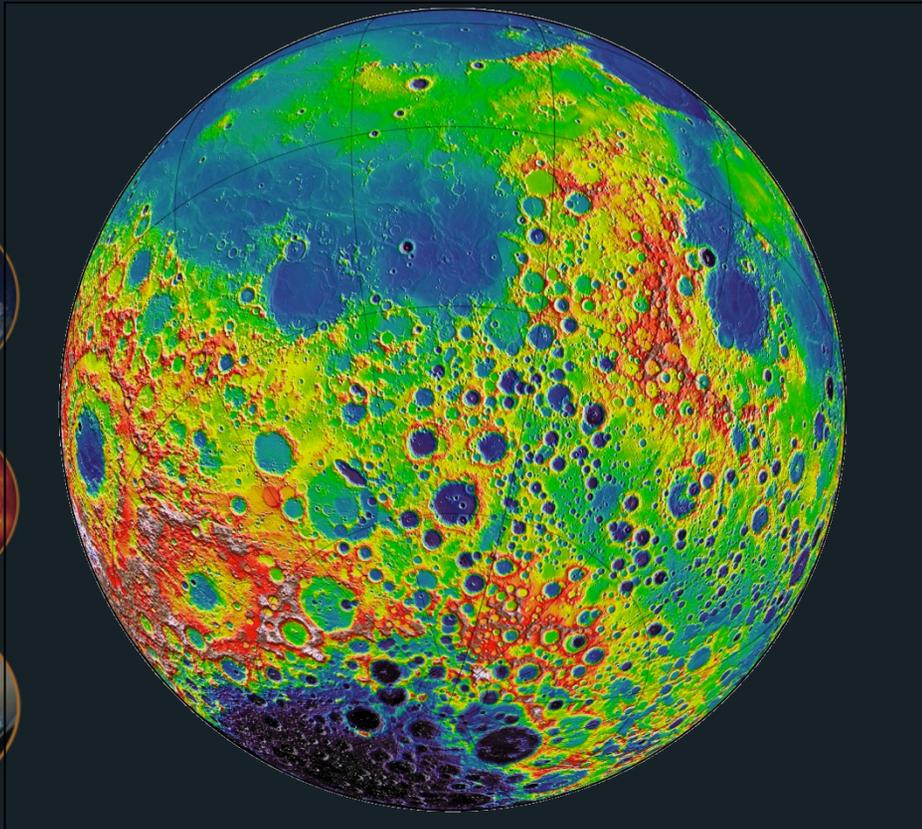


Cassini - Saturn,
it's rings and Huygens
probe first color image
of Titan



Mars Orbiter Laser Altimeter

Topographic Map of the Moon



The LOLA instrument has begun to produce altimetry data that when complete, will measure the lunar surface accurate to a few centimeters.

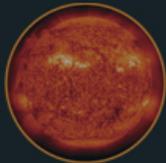
Juno – Mission to Jupiter



PI: Scott Bolton SWRI
Deputy PI and Magnetic Field Investigation:
Jack Connerney (GSFC)

Launched 2011, arrival July 2016

First solar powered mission to Jupiter



Look deep into Jupiter's atmosphere

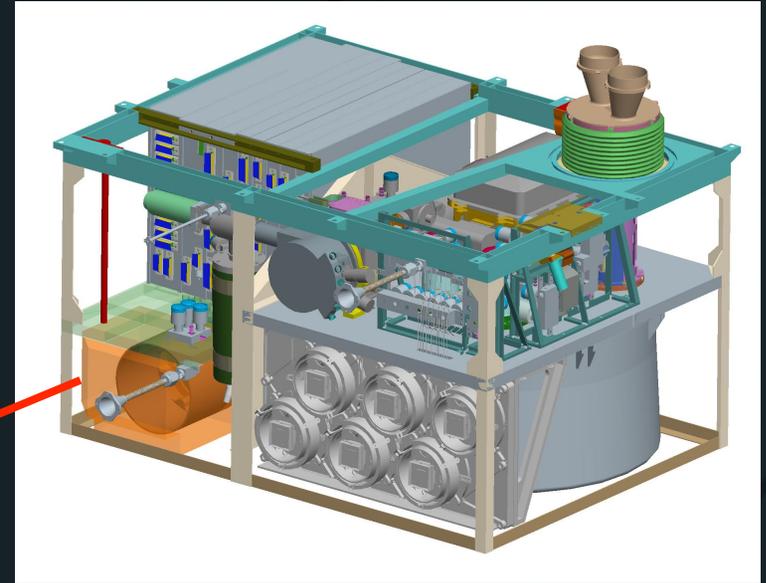
Determine how much water is in Jupiter's atmosphere

Map Jupiter's magnetic and gravity fields, revealing the planet's deep structure

Explore and study Jupiter's magnetosphere near the planet's poles

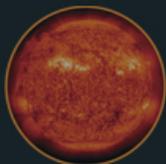
Sample Analysis at Mars (SAM)
PI: Paul Mahaffy (GSFC)

SAM is a suite of instruments on the Curiosity Mars rover that will reveal the potential for life on Mars – the flagship instrument



- Search for organic compounds of biotic and prebiotic relevance
- Study habitability of Mars by measuring oxidants
 - Investigate atmosphere and climate evolution

SAM Team Celebrates Landing on Mars





*Mars Atmosphere and Volatile Evolution
(MAVEN) Mission*

*Bruce Jakosky, Principal Investigator
from University of Colorado*

*First NASA mission to Mars managed
by GSFC*

Launch November 2013

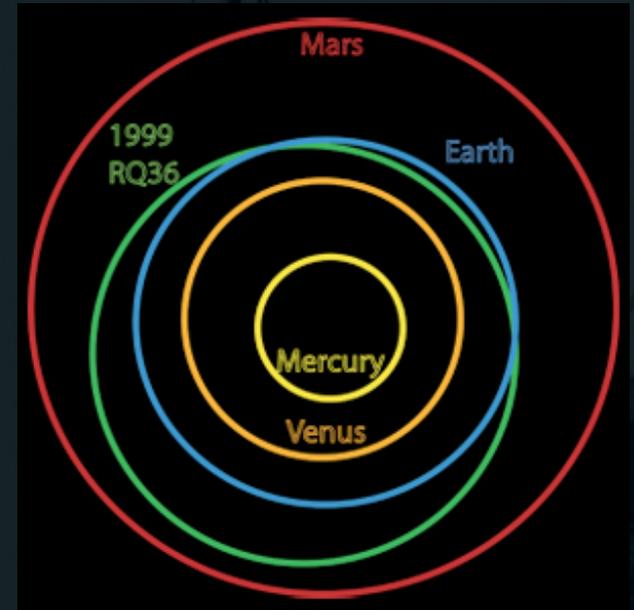
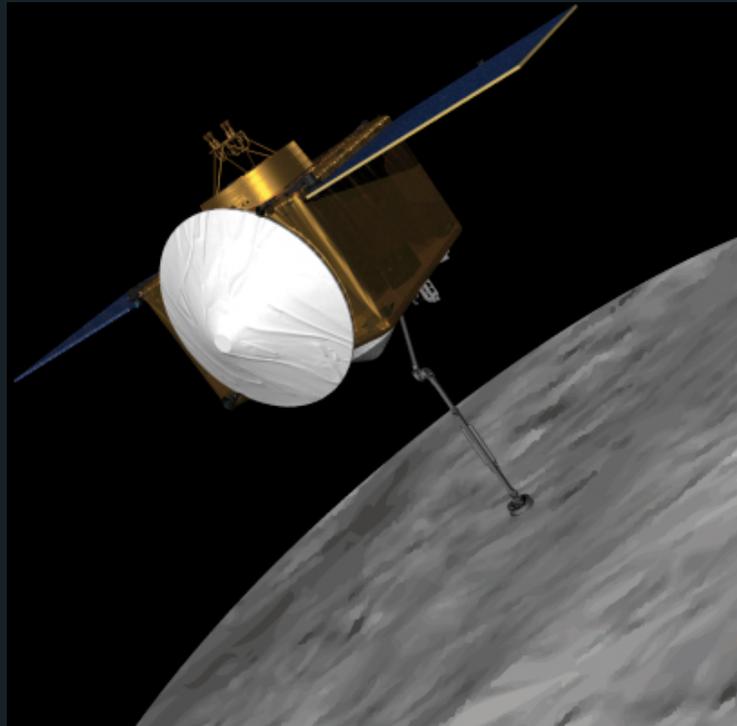
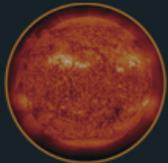
*Loss from the upper atmosphere to
space is key to determining the history
of the atmosphere, climate, and water,
and thereby understanding Martian
habitability.*



Asteroid Sample Return

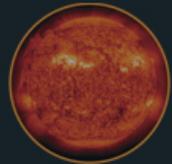
OSIRIS-REx: Origins-Spectral Interpretation-Resource Identification-Security-Regolith Explorer

Asteroid sample return mission managed by GSFC
PI: Dante Lauretta, University of Arizona

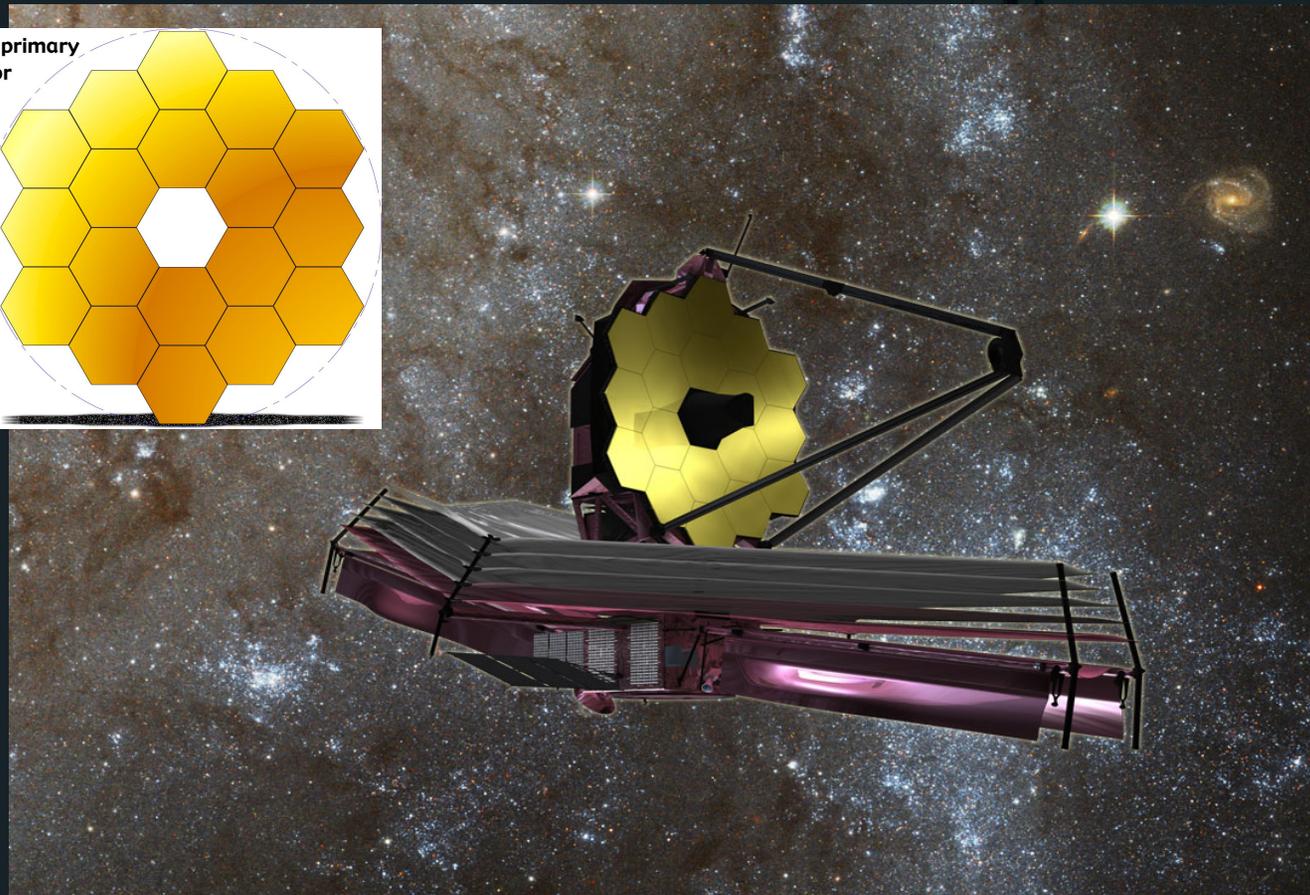
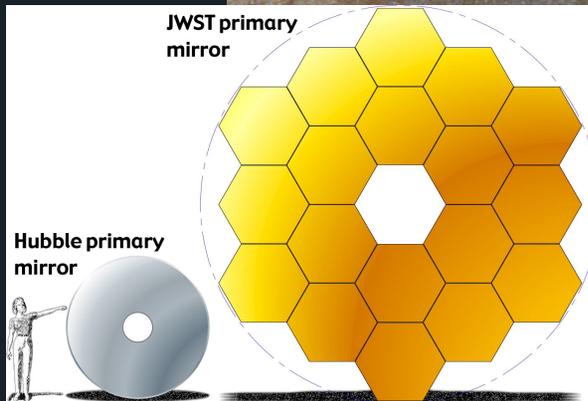


Launch 2016
Rendezvous with 1999 RQ36 in 2020
Sample return to Earth in 2023

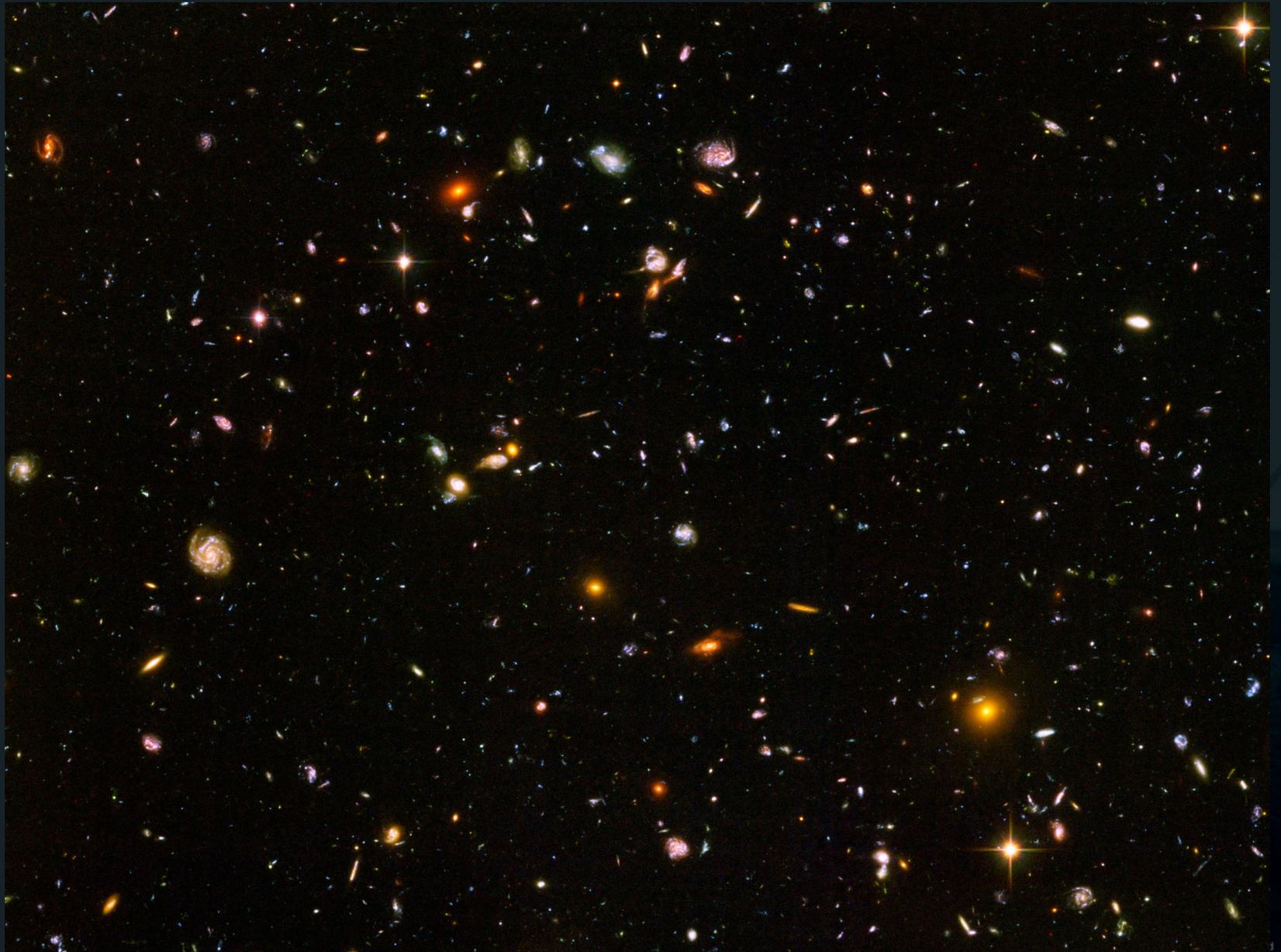
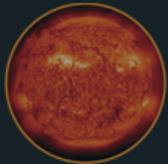
- Observing the first galaxies that formed 500 million years after the Big Bang
- Follow their evolution to the modern day Universe
- Characterizing Extra Solar Planets



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Hubble Deep Field

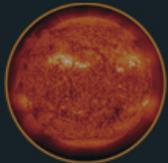
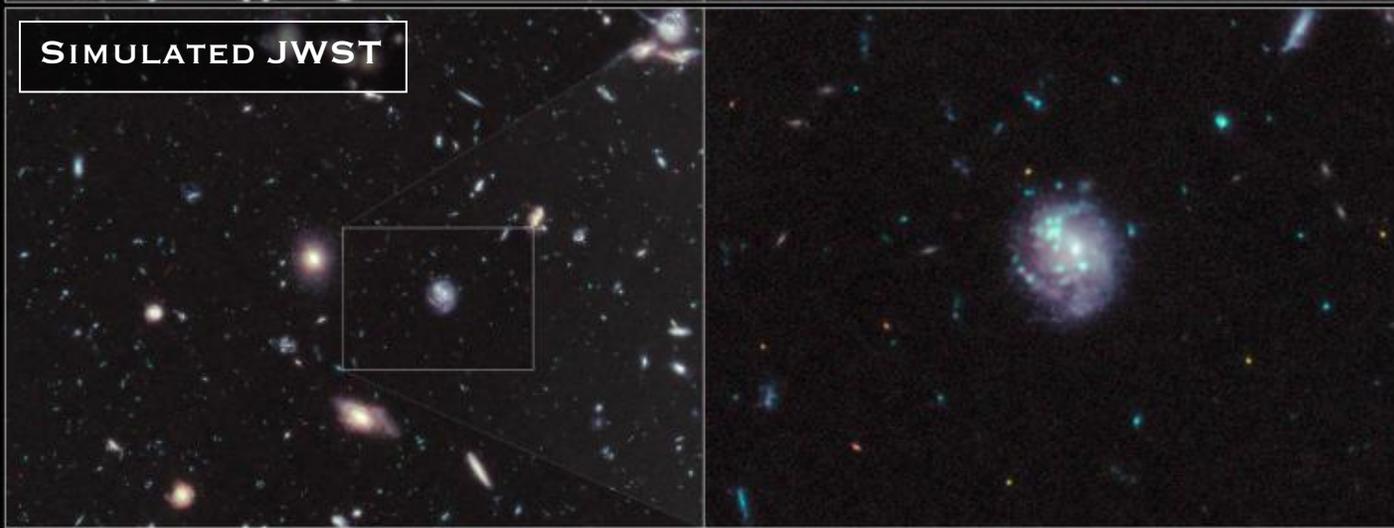


JWST SCIENCE THEMES – THE END OF THE DARK AGES

THE HUBBLE UDF
(F105W, F125W, F160W)



SIMULATED JWST

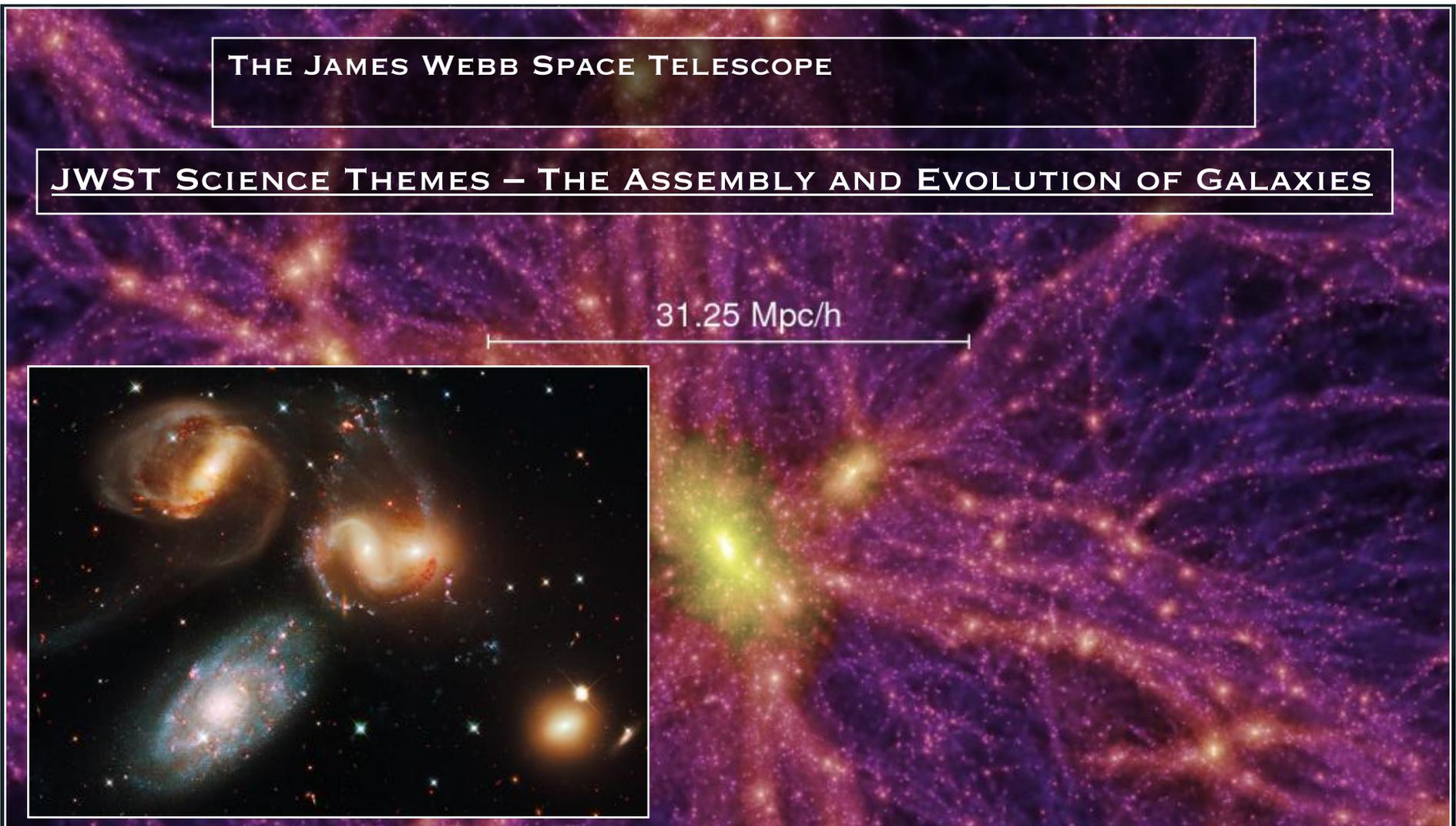


JWST WILL HAVE HIGHER ANGULAR RESOLUTION THAN HUBBLE FOR DEEP FIELD

THE JAMES WEBB SPACE TELESCOPE

JWST SCIENCE THEMES – THE ASSEMBLY AND EVOLUTION OF GALAXIES

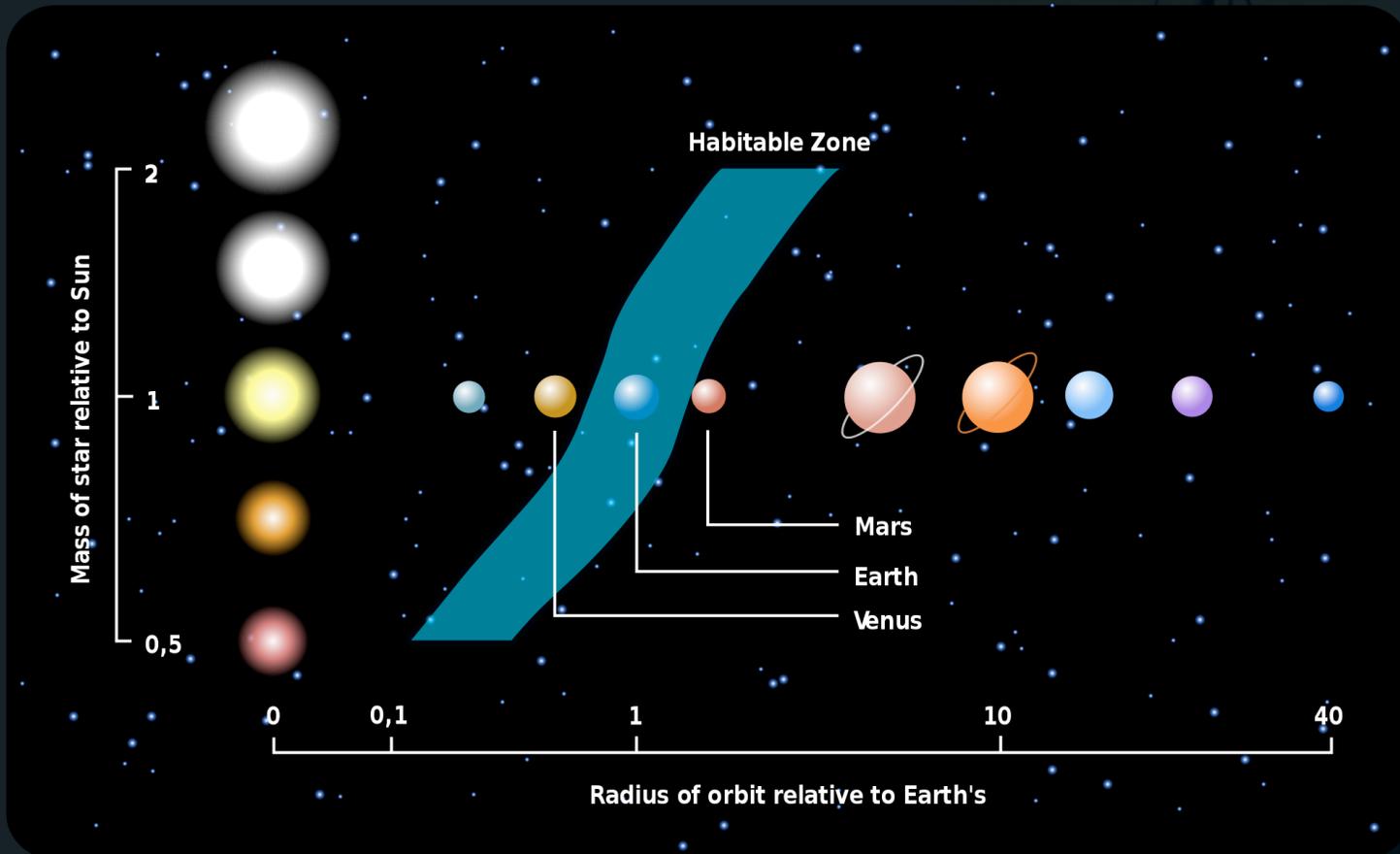
31.25 Mpc/h



JWST QUESTIONS

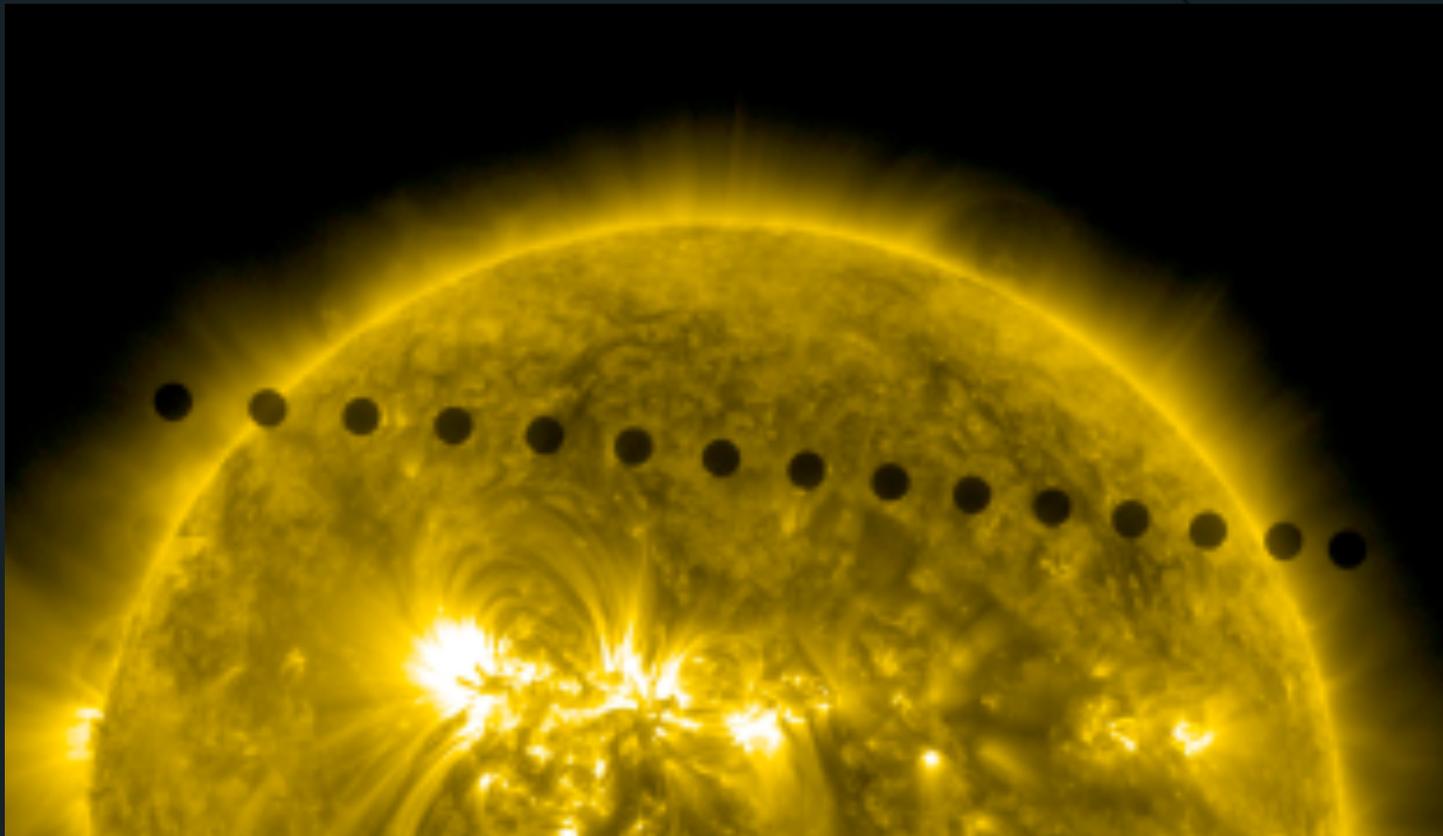
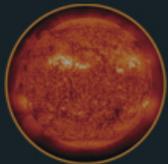
- 1.) WHERE AND WHEN DID THE HUBBLE SEQUENCE FORM?
- 2.) DO HIERARCHICAL FORMATION MODELS AND GLOBAL SCALING RELATIONS EXPLAIN DIVERSE GALAXY MORPHOLOGIES AND THEIR COSMIC EVOLUTION?
- 3.) HOW DID THE HEAVY ELEMENTS FORM?
- 4.) WHAT ROLE DO ULIRGS AND AGN PLAY IN GALAXY EVOLUTION?

Where are the nearest Terrestrial Planets?
Do any other planets harbor life?



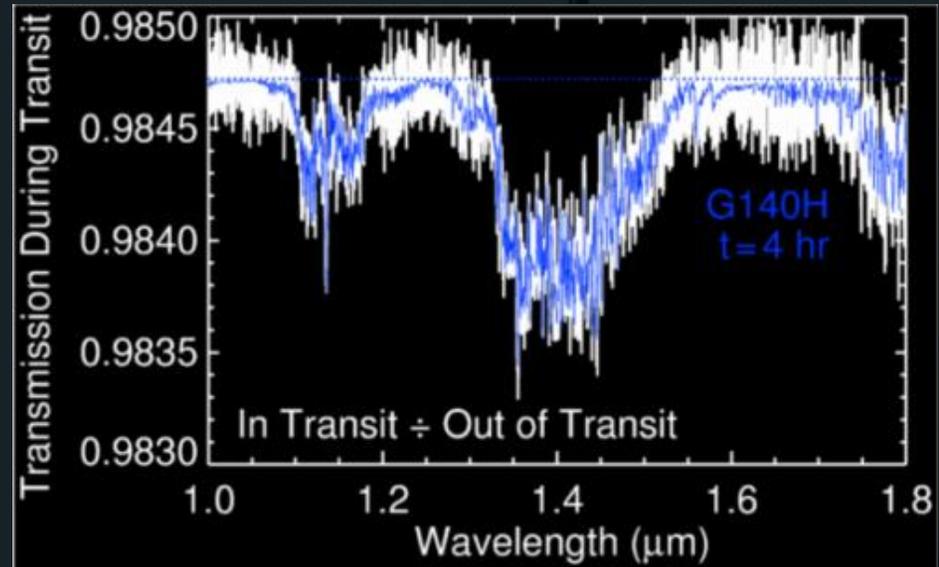
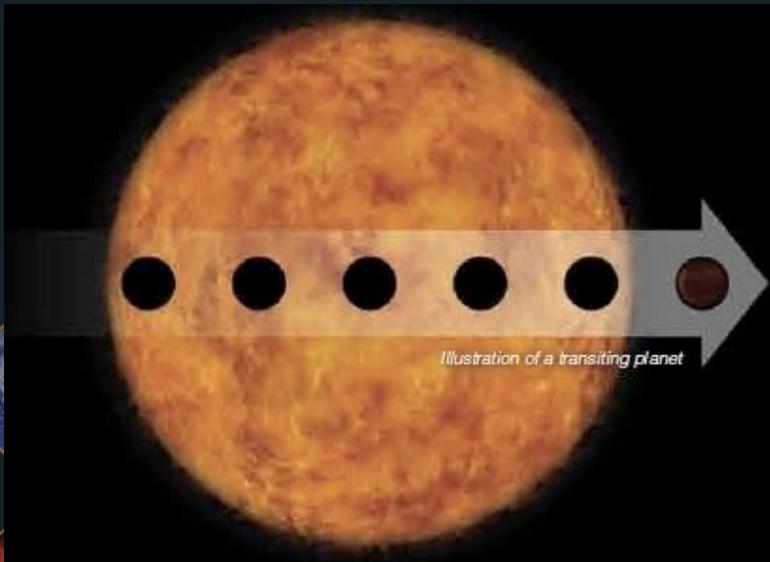
Transit of Venus

- On June 5 Venus passed in front of our Sun, which caused a very small drop in the solar brightness



The same technique is being used by NASA satellites to find planets orbiting other stars: so called Extra solar planets (Exoplanets)

JWST SCIENCE THEMES – THE ORIGINS OF LIFE



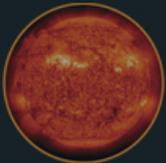
ATMOSPHERIC TRANSMISSION SPECTRUM (4 HOURS) FOR HD209458-LIKE KEPLER SOURCE USING NIRSPEC (R=3000).
SIMULATION FROM J. VAN LEEWEN

JWST QUESTIONS

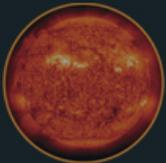
- 1.) HOW DO PLANETS FORM?
- 2.) WHAT ARE THE PROPERTIES OF CIRCUMSTELLAR DISKS LIKE OUR SOLAR SYSTEM?
- 3.) WHAT CRITERIA SHOULD BE USED TO ESTABLISH HABITABLE ZONES?
- 4.) IS THERE EVIDENCE FOR LIQUID WATER ON EXOPLANETS?

JWST WILL DETECT WATER IN HABITABLE ZONE SUPER EARTHS

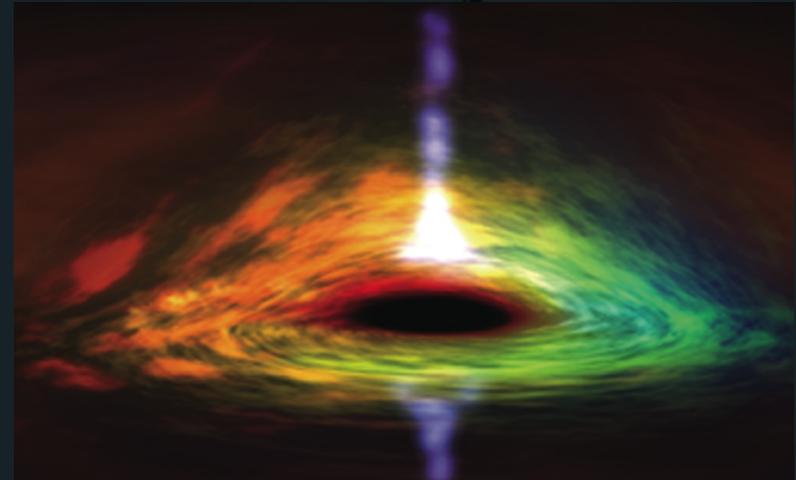
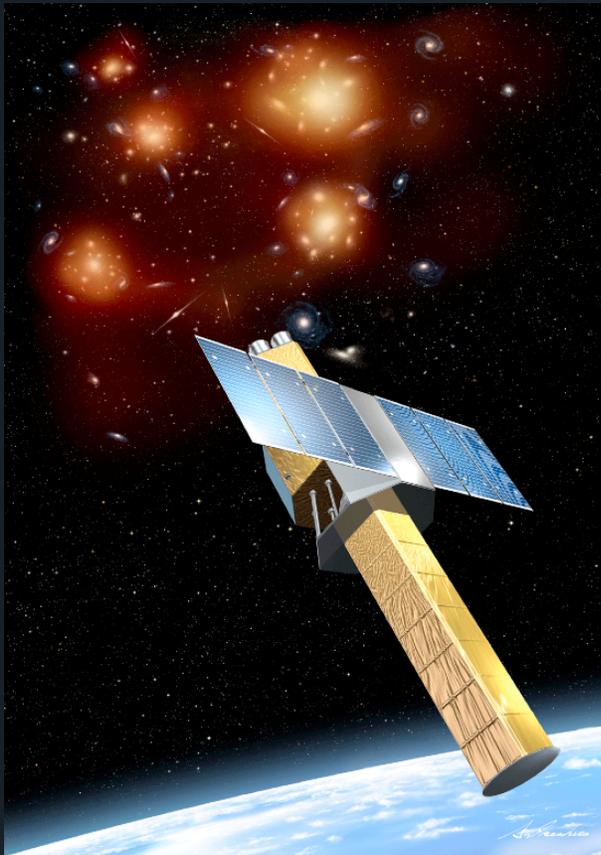
JWST Mirrors in their containers at Ball Aerospace



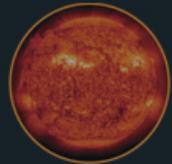
First two JWST mirrors delivered to GSFC



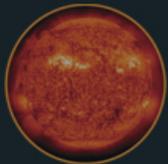
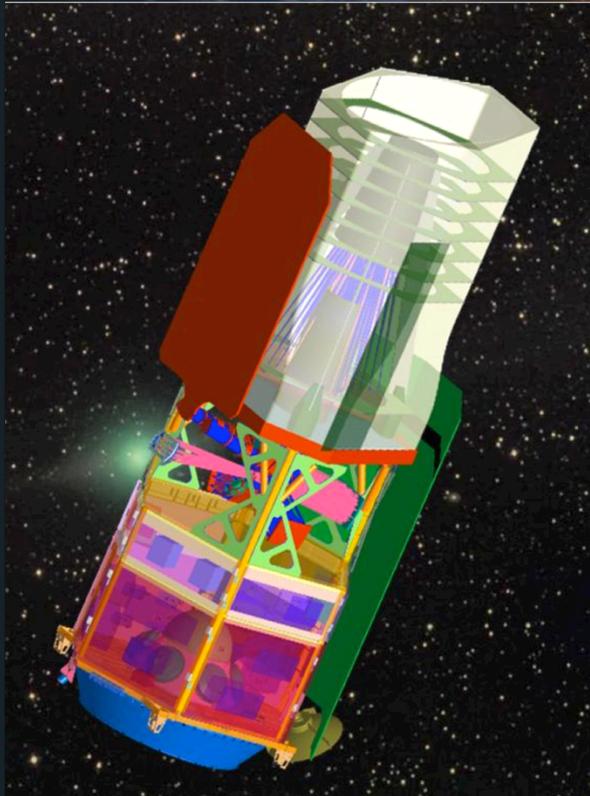
Observing matter falling into a Black Hole



Clusters of Galaxies and Dark Matter



NASA/GSFC providing an X-ray spectrometer for the JAXA Astro-H mission in 2014
(P.I. Richard Kelley)



Different implementation options being studied for launch after JWST

Wide Field Infra-Red Survey Telescope – WFIRST

Large scale surveys of the sky in the infra-red

Precisely measure the expansion and geometry of the Universe to study Dark Energy

Search for Extra-solar planets

Launch 2023(?)

